A FLUELESS HOT WATER/SPACE HEATING SYSTEM

- INSTALLATION REPORT -

UNDERTAKEN JOINTLY BY THE ONTARIO MINISTRIES
OF MUNICIPAL AFFAIRS AND HOUSING AND
ENERGY UNDER THE HOUSING ENERGY
MANAGEMENT PROGRAM (H.E.M.P.)

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RESEARCH AND DEVELOPMENT SECTION
TECHNICAL SERVICES DIVISION

BY

UNION GAS LIMITED

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SUMMARY

Following an agreement with the Ministry of Municipal Affairs and Housing, and funded by the Ministry of Energy, Union Gas Limited has undertaken to field test a flueless hot water/space heating system. With a potential combined efficiency of some eighty percent, this system appears comparative with other high efficiency equipment currently on the market.

An approved test location was chosen and work begun as to the layout and operation of the equipment. In selecting a test procedure, it was agreed to operate on a flip/flop basis with the test unit in parallel with a conventional water and air heating system.

This report is an interim brief concerning the installation and operating procedures of the test equipment. Actual test results are expected upon completion of the '82 - '83 heating season.

1.0 INTRODUCTION

1.1 STUDY PROPOSAL

Having expressed a mutual interest in current "high efficiency" heating equipment, the Ontario Ministry of Municipal Affairs and Housing and Union Gas Limited, through funding provided by the Ministry of Energy, entered into a joint agreement to investigate a flueless domestic hot water (DHW) and forced air heating system. Of particular interest was the potential energy savings of such systems with respect to conventionally vented domestic hot water and space heating installations. Additional interest was expressed regarding the individual component efficiencies in comparison to the total integrated system performance. With these objectives, and a combined flueless system selected, attention was then directed to the selection of a suitable test location.

1.2 SELECTION OF TEST SITE

In selecting a test location, several requirements were considered. A brief summary of these guidelines has been included in Appendix A for reference.

Aside from these preferred characteristics, a conscious effort was made to select a location which would be representative of a "typical" application with respect to house construction and heating requirements. In addition, preference was given to existing gas furnace and water heating installations. With this combination, it was felt that valuable information could be gained as to the flue requirements and total equipment performance.

Having considered these, a decision was reached in selecting a test location. Appendix B gives a brief outline as to the actual site selection and the equipment present.

2.0 COMBINED SYSTEM OPERATION

2.1 OPERATING FEATURES

The combined space heating/DHW unit under consideration is a circulating water/glycol system. The combined system is comprised of an outdoor combustion and circulating unit, an indoor fan cabinet with a fin tube heat exchanger, and an internally insulated hot water tank. Upon a call for space heating, the outdoor unit circulates a hot glycol/water solution to the indoor heating coil. A temperature sensor in the air unit controls the cycling of the fan/coil combination (on/off at approximately 43°C) to meet the space heating requirement, or until there is a heating demand for DHW. Upon demand for domestic water heating, a diverting valve at the air unit directs the heating solution from the air coil to the DHW tank. With priority over space heating, the DHW tank continues heating until it has met the water heating requirements. Having satisfied both the space heating and domestic water requirements, the outdoor unit shuts down.

2.2 LAB TESTING

Although it is often preferable to pre-test new equipment in the Utilization Lab, a decision was reached to install this system without prior testing. The basis of this decision was in the need to install the new equipment as quickly as possible in order to gain the advantage in collecting low degree day data. In addition, this provided an opportunity to experience those difficulties and questions as would face an inexperienced contractor.

Finally, significant difficulties were seen in the setting up of such water circulating systems given obvious lab facility limitations. Aside from the manufacturer's literature, no experience or additional information was available.

3.0 FIELD TESTING PROCEDURES

3.1 OPERATIONS

In conducting a performance evaluation of the combined system, it was felt that a flip/flop procedure is currently the best method for such comparative studies. The method itself involves the operation of the two test systems for alternate periods. Connected in parallel, using interconnecting duct work and appropriate sub-metering, one is able to alternate operation of the systems accordingly.

3.2 METERING

The metering requirements needed to accurately monitor the system involved; individual gas sub-metering, KWH meters, a temperature recorder and additional energy (BTU) metering. The (air/solution) BTU metering was designed to provide individual unit consumptions, enabling one to determine component seasonal efficiencies. In addition to the BTU records, total solution volumes (gallons) were also recorded. This information was to provide an indication of the systems operation as to DHW/space heating requirements (given a constant flow rate through the system). A one (1) week operating (flip/flop) schedule was selected.

Finally, weather data and degree day information was to be available through local station records as supplied by Atmospheric Environment Services of Canada.

4.0 INSTALLATION FEATURES

4.1 GENERAL

In order to provide a "typical" installation, a decision was reached to limit supervision and instruction to the contractor. Yet, in the interests of the special monitoring requirements and the relative complexity of the installation, an installation package was compiled

4.0 INSTALLATION FEATURES (con't)

4.1 GENERAL (con't)

(Appendix C) and issued to the Contractor. This it was felt did not jeopardize the actual learning experience of installing new equipment.

4.2 SITE CONSIDERATIONS

In locating the equipment, particular attention had to be given to local municipal bylaws and the construction details of the house (ie. distances from house openings, location of fan cabinet, existing duct design, etc.). These factors in turn, were to dictate the piping requirements; or more specifically, the need to provide 2.54 cm (1 inch) piping. This decision was based on the manufacturer's specifications as to the total allowable equivalent feet as determined by the maximum head restriction of the circulating pump.

In addition to adequate piping, difficulties were encountered in locating the energy metering. Of particular importance was the positioning of the air BTU vane in a uniform, representative (ie. average temperature and velocity) air stream in the main return trunk. To provide these conditions, a decision was made to block one of the existing return grilles.

A third area of consideration was the need to partially re-pipe the domestic water system. This was necessary in order to provide parallel operation of the system and to facilitate additional BTU metering.

Finally, attention was turned to finding a means of blocking the existing flue during the operation of the test system. This procedure was designed to eliminate potential energy losses up the chimney when the test (flueless) system was operating.

4.3 SYSTEM BALANCING

Aside from the installation requirements, an important

4.0 INSTALLATION FEATURES (con't)

4.3 SYSTEM BALANCING (con't)

concern was realized in the actual matching of the test and conventional equipment. In matching the performance of each system, particular attention was given to temperature rise (for both air and water systems), air quantities (L/S) and external static pressures. Appendix B provides a brief summary of the final settings achieved for each system.

5.0 SYSTEM INSTALLATION

5.1 REMARKS

Upon inspection of the site during installation, several problems dealing with procedures and workmanship surfaced. Briefly, these were as follows:

1) The supply and return solution lines of the test system were reversed by the contractor at the outdoor unit.
2) The 24V protection fuse in the indoor cabinet had been blown and simply shorted across without investigating the problem further.
3) The manufacturer's instructions as to the charging of the outdoor unit were not followed. In neglecting to follow these suggested procedures, the contractor improperly charged the system; resulting in potential air lock problems.
4) In charging the outdoor unit, tap water had been used in place of distilled de-ionized water; again contrary to instructions.
5) The filter rack (optional for the air unit) was poorly installed by the contractor.
6) The solution lines were poorly insulated; with over sized insulation and untaped joints.
7) The return solution line was poorly soldered at the connection to the water tank. Here the manufacturer

5.0 SYSTEM INSTALLATION (con't)

5.1 REMARKS (con't)

7) (con't)
had made it clear that particular attention had to be given in connecting the solution lines to the tank as it is internally lined.

8) The gas shut-off valve at the outdoor unit was in violation of the gas code (approved for indoor use only).

9) An improper temperature/pressure relief valve was installed, again contrary to specific instructions from the manufacturer. In using the smaller relief, inadequate protection was given to the operation of the DHW tank.

With the installer making the required corrections, and the energy (BTU) metering installed, the installation was scheduled for commissioning.

6.0 MONITORING

6.1 PROCEDURE

In monitoring the systems, a decision was made to have the homeowner cycle the equipment and record the necessary information as per a specific schedule. This it was felt would provide a convenient, yet reliable means of cycling the equipment. To ensure consistency in the operation and recording of data, an operating package was prepared and distributed to the homeowner. In addition, Union Gas staff were to inspect the site regularly and review test results on a continual basis. (See Appendix D).

7.0 COMMISSIONING

7.1 ANTICIPATION SETTINGS

During the commissioning of the equipment, a concern existed regarding the thermostat control of the systems.

7.0 COMMISSIONING (con't)

7.1 ANTICIPATION SETTINGS (con't)

Of particular concern were the wide variances in suggested anticipation requirements and the possibility of mismatching and cycling inaccuracies. To avoid these errors, an isolating circuit was installed which served to draw a fixed current through the thermostat while allowing the individual units to operate independently.

8.0 CONCLUSIONS

8.1 REMARKS

With the installation and commissioning trials completed, the test site began operation. To date, the installation has been operating smoothly, with few problems. The related costs of this project are reported in Appendices E and F.

8.2 INTERIM COMMENTS ON THE INSTALLATION

1) The equipment itself appears to be fairly well designed and constructed.
2) The actual installation of the equipment is not difficult. It is however involved and thus requires particular attention in the following areas:
   i) connecting to the DHW tank
   ii) location of the outdoor unit and resulting pipe requirements.
   iii) Soldering of the fittings.
3) In the design of the solution piping requirements for the system, the manufacturer has suggested a maximum equivalent length of 18.29 metres (60 ft.) of pipe. This equivalent length restriction is the result of the capacity limitations of the circulating pump. There remains however some uncertainty as to exceeding this condition. It is not unreasonable for example to suggest applications, both in retrofit and new construction, where the 18.29 metre (60 ft.) constraint could not be met

8.0 CONCLUSIONS (con't)

8.2 INTERIM COMMENTS ON THE INSTALLATION (con't)

3) (con't)
(at this location there is some 54.88 equivalent metres (180 ft.) of pipe installed). In addition, there is a suggested head restriction (ie. pressure differential) of 2.44 metres (8 ft.) on the pump; again limiting possible applications of the equipment.

4) It remains uncertain as to whether the manufacturer has given consideration to the glycol (ie. viscosity changes and thus pump performance) in calculating the allowable equivalent feet.

5) Vibrations transmitted from the solution lines strapped to the floor joists are noticeable.

6) The wiring diagram as supplied by the manufacturer was incomplete (24V protection fuse omitted). The diagram attached to the blower cabinet was however complete.

7) In matching the equipment for test purposes, particular attention was given to bonnet capacities, air volumes, temperature rise, and static pressures. Inevitably, compromises had to be made in selecting the best operation of the systems.

8) Difficulty was found in achieving the performance characteristics (ie. air volumes vs external static pressures vs temperature rise) of the air handler as specified in the manufacturer's literature. Early indications suggest that the problems exist in the low speed capacity of the blower/motor assembly.

9) Connections to the base of the water tank are awkward. Modifications may be necessary to properly fit the piping.

10) Although not specified, a drain valve in the glycol/water lines could prove very useful should the system require periodic maintenance (ie. re-soldering of one of the fittings).

8.0 CONCLUSIONS (con't)

8.2 INTERIM COMMENTS ON THE INSTALLATION (con't)

11) The charging procedure, although rather involved (15 - 30 min.), is well documented and not expected to be beyond the abilities of most contractors.

12) A leak was noticeable at one of the spring hose clamps in the outdoor unit.

13) The manufacturer's literature was fairly complete and well illustrated.

14) Difficulties were found in locating contractors who could perform all aspects of the job: gas fitting, plumbing and duct fabrication.

15) The outdoor unit pad is only briefly described in the literature. Further elaboration may be required to ensure proper support of the unit.

16) Indications suggest that to ensure the proper installation of the equipment, the manufacturer should provide training in specific areas. Of particular concern, are:

    i) the calculation of total equivalent feet and how it may effect the installation design
    ii) the charging procedure of the outdoor unit
    iii) the installation of the DHW tank (here again, particular attention has to be given in connecting all lines to the tank).

While some of the above issues are perhaps unique to this manufacturer and unit model, they do serve to illustrate potential difficulties of similar combined systems. With increased training however and more experience with such systems, the incidence of such problems could be reduced.

PREPARED BY: R. B. BATES

REVIEWED BY: M. P. MCCRAE, P. ENG.
J. M. JONES

APPROVED BY: P. E. DUMOUCHEL, P. ENG.

APPENDICES

SITE CRITERIA

The following is a list of criteria required of each test site:

1. Natural gas service must be available.
2. The home must be kept at a constant temperature during the heating season. No night setback is allowed.
3. Access to the home must be made available given reasonable notice.
4. The use of any other heating source, such as an electric heater or fireplace, will not be allowed.
5. The existing furnace must have an input between 17.59 and 29.31 KW (60,000 and 100,000 BTUH).
6. No energy savings alterations are to be done during the test (ie. caulking, weather stripping, insulating).
7. The space requirements of the new furnace is approximately 1.52 m x 2.13 m x 2.13 m (5' x 7' x 7') high. This space is to be adjacent to the existing furnace, as both units will be used in the study.
8. Preferably, the site would have a gas furnace and water heater presently installed.
9. Space must be available to locate the heating unit outdoors.
10. The homeowner must be available to switch the equipment and record the required data, at or about, the same time each week.
11. A fuel consumption history (ie. 5 yrs.) would be beneficial.
12. A southern location within the company franchise would serve to provide a low degree day installation.

TEST LOCATION

SITE: - 112 Thornhill Crescent, Chatham, Ontario

HOUSE CONSTRUCTION
- Single family side-split with basement
- frame construction with brick veneer
- 1975 construction (approx.)
- partially insulated basement walls
  - 1.23 RSI (R-7) insulated
  - 0.35 RSI (R-2) uninsulated
- 2.64 RSI (R-15) ceiling
- 1.94 RSI (R-11) walls
- 189 M^2 (2034 sq. ft.) living area including basement
- 14.21 KW (48476 BTUH) calculated heat loss

EXISTING FURNACE:
- Inter City
- Gas-fired

RATED	MEASURED
Input 29.31 KW (100,000 BTUH)	28.78 KW (98,200 BTUH)
Bonnet 21.98 KW (75,000 BTUH)	22.46 KW (76,619 BTUH)
$\triangle T$ = N/A	52.2°C (94°F)
Air Volume = N/A	346.7 L/S (741 cfm)
Ext. Static Press. = N/A	44.8 Pa (0.18" W.G.)
Comb. Efficiency = 75%	78%

* suggested anticipation = 0.2 Amps.

EXISTING WATER HEATER
- gas fired Model RG-40-40S
- rated input 11.72 KW (40,000 BTUH)
- measured thermostat setting = 57.2°C (135°F) approx.

TEST EQUIPMENT A
- Amana HTM Plus Hot Water/Space Heating System
- ERGW 0012-1A outdoor unit
- gas-fired

RATED	MEASURED
Input 29.31 KW (100,000 BTUH)	27.76 KW (94,700 BTUH)
Output 24.53 KW (83,700 BTUH)	

B
- EBWC 3612 M-A indoor unit

Measured
$\triangle T$ = 47.8°C (86°F)
Air Volume = 318.6 L/S (675 cfm)
Ext. Static Press. = 86.67 Pa (0.36" W.G.)
* suggested anticipation = 0.8 Amps.

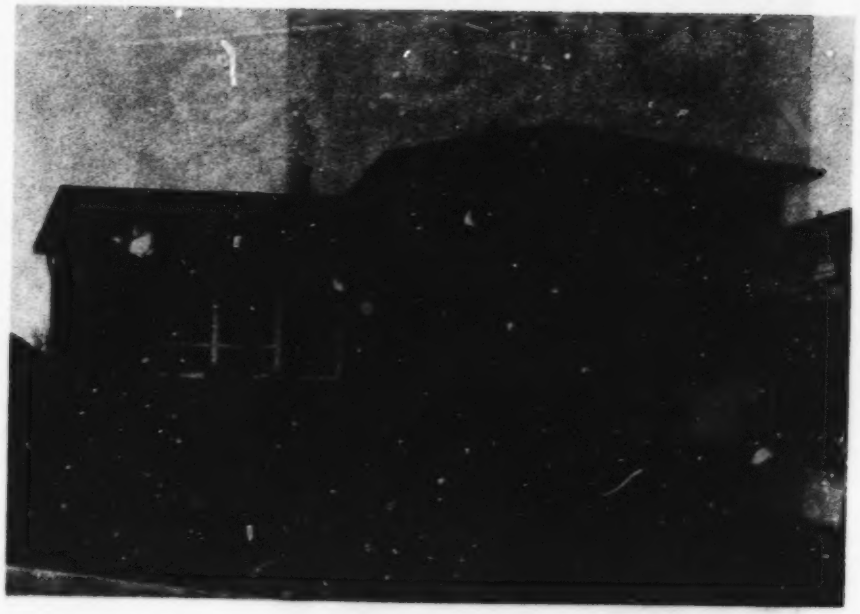
TEST EQUIPMENT - (Con't)

C - EGWH 0040 X-A water heater
Rated capacity = 151.5 L (40 gal. U.S.)
Measured thermostat setting = 57.2°C
(135°F) approx.

* An isolating circuit has been installed to provide a constant 0.41 Amp. draw through the thermostat.

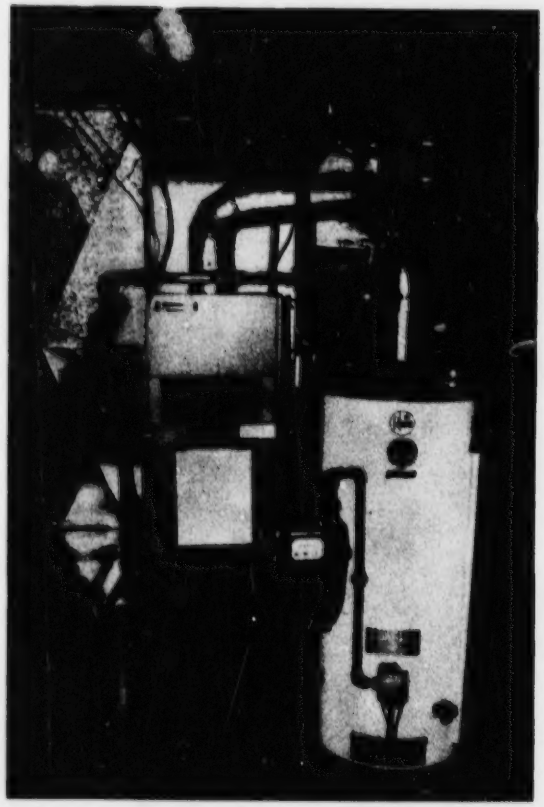
Outdoor Combustion Unit

fig. 1



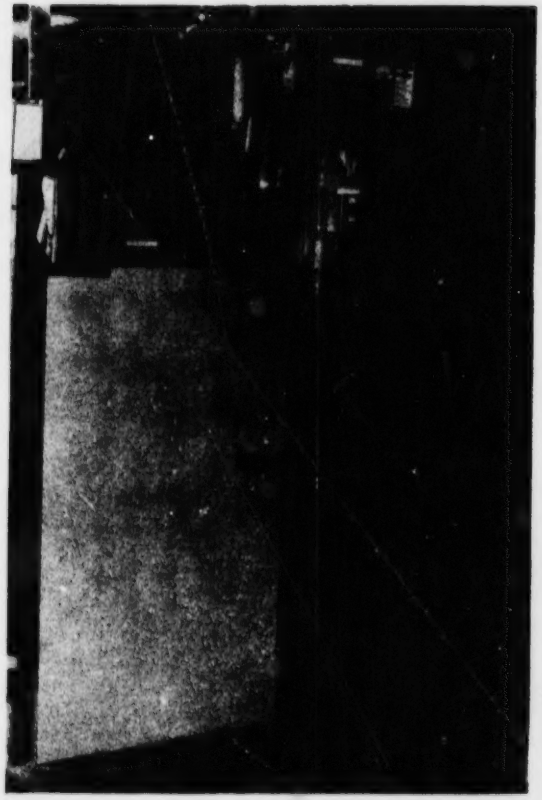
Test Location

fig. 2



Conventional Furnace/DHW System

fig. 3



Fan Cabinet/DHW Test System

fig. 4

* INSTALLATION INSTRUCTIONS TO CONTRACTORS

INSTALLATION REQUIREMENTS AND INSTRUCTIONS

UNION GAS

SEPTEMBER, 1982

* In addition to those provided by the Manufacturer.

SPECIAL NOTES TO THE HTM PLUS INSTALLATION INSTRUCTIONS

GENERAL

i) The contractor is to supply all materials (including fluids) required to complete the installation in accordance with the manufacturer's instructions, the layout diagrams and specifications, and local codes.

ii) The contractor shall provide a charging apparatus as prescribed by the manufacturer. In addition to this, the system is to be initially charged by the Contractor with a 55% (by volume) propylene/de-ionized distilled water solution.

iii) All leads continuing through to the exterior (ie. plumbing, 110 V. and 24 V. electrical) should pass through a common conduit (ie. 4" ABS) which is to be fiberglas packed.

PLUMBING

i) All piping is to be 1" type L copper tubing.

ii) All solution piping external to the Amana units shall be properly insulated with 3/8" wall "armaflex".

iii) The manufacturer's instructions as to soldering the diverter valve and Amana water tank, are to be specifically adhered to.

iv) The water tank is to be equipped with a relief valve and down pipe in accordance with local code.

v) The domestic hot and cold water piping is to be adjusted as required to accommodate the additional Amana tank.

DUCT WORK

i) The damper blades (2) are to be constructed as to provide a proper seal.

ii) To provide adequate clearance, the bathroom flooring is to be trimmed to the floor joist (approx. 1").

iii) A manual damper system is to be installed in the existing furnace/hot water venting. The damper shall include an automatic safety switch to disconnect furnace/heater operation with the damper closed. In addition, the damper effects should be minimal during normal operation of the gas furnace and hot water heater.

iv) A permanent filter and rack (as supplied by Amana) is to be fixed to the Amana blower unit.

v) An existing domestic water pipe will need relocating to provide adequate plenum clearance.

... 2

ELECTRICAL

i) A kilowatt-hour meter (as supplied by Union Gas) is to be installed as illustrated in the wiring diagram.

GAS PIPING

i) Gas meters with remote recording (as supplied by Union Gas) are to be installed as illustrated in the gas piping diagram.

OUTDOOR UNIT

i) A 4" x 26" x 22" Concrete pad is to be poured to provide a solid, level foundation for the outdoor unit.

ADDITIONAL METERING

i) In addition to the electrical and gas metering, the Contractor will be responsibile for installing three (3) Btu meters. All Btu hardware (ie. flow meters and temperature sensors) is of a pressure fit design. As these meters are presently unavailable (on order September 28, 1982), provision should be made to retrofit this equipment.

ii) The Contractor will locate and install check valves in the domestic water lines. These valves shall be located in the vertical position and located in accordance with the supplied diagrams. (Supplied by Union Gas.)

iii) In addition to the three (3) fluid Btu meters, one (1) air Btu meter is to be installed in the extended return air duct. Positioning of this meter is critical and is to be approved by this department before installation. This meter is not a compression fitting and is to be installed in accordance with the manufacturers instructions.

WRITTEN ESTIMATES

i) Written estimates are to be prepared (including all taxes, labour, materials, etc.) such that regular installation costs and those incured due to the study are easily separated.

Example:

Regular Installation Costs

a) Materials

-
-
-
-

b) Labour

-
-
-

c) Other

-
-
-

SUB-TOTAL $

Study Costs

a) Materials

-
-
-

b) Labour

-
-
-

c) Other

-
-
-

SUB-TOTAL $

TOTAL $

ii) Study incurred costs may include such items as:

a) installation of metering devices

b) interconnecting duct work and dampers

iii) The written estimates are due no later than:

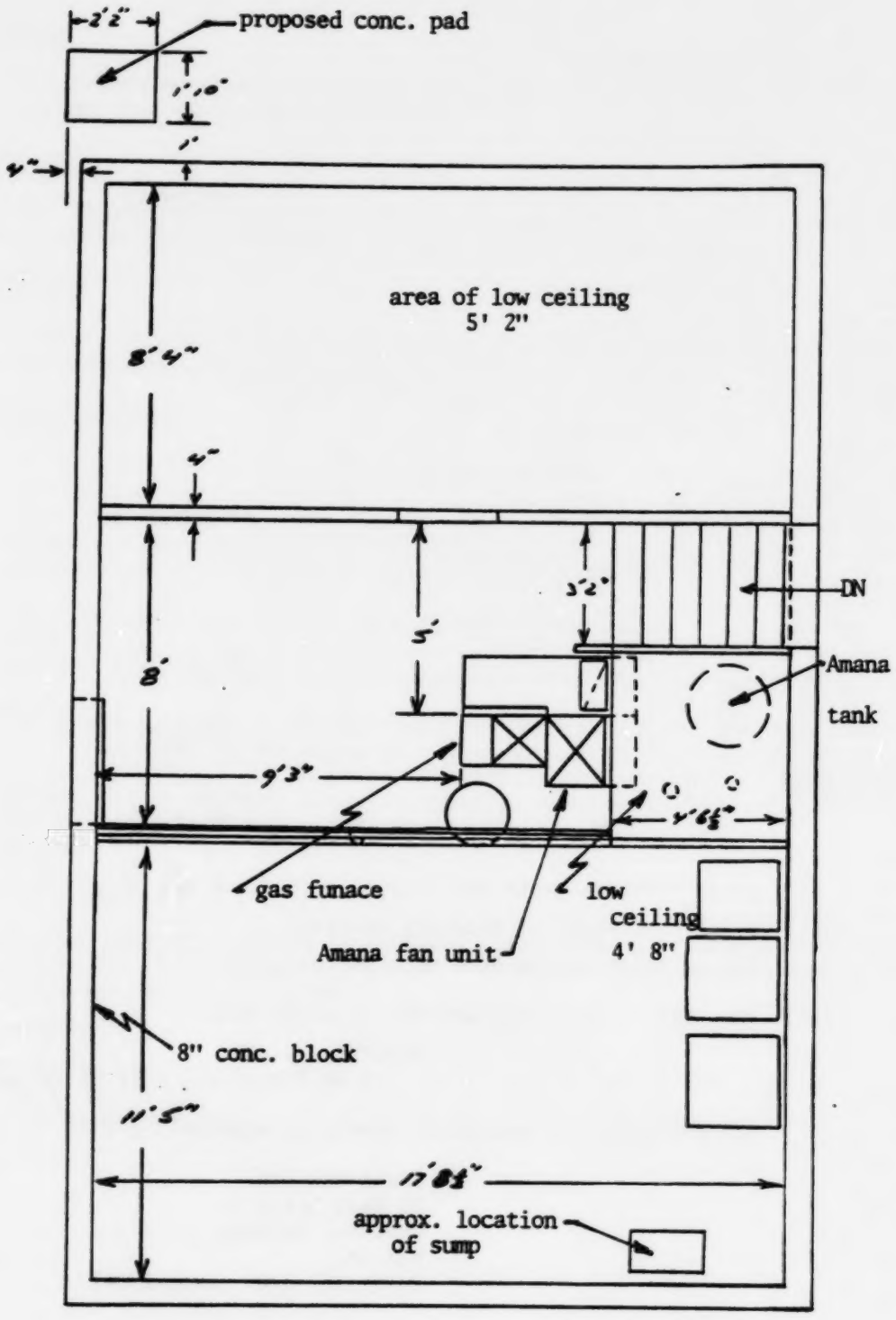
OCTOBER __, 1982
3:00 P.M.

All estimates and questions should be addressed to:

UNION GAS LTD.
50 Keil Drive N.
Chatham, Ontario
N7M 5M1
(519) 352-3100 (Ext. 2734)

ATTENTION: R. Bates
Engineering Services

FLOOR PLAN

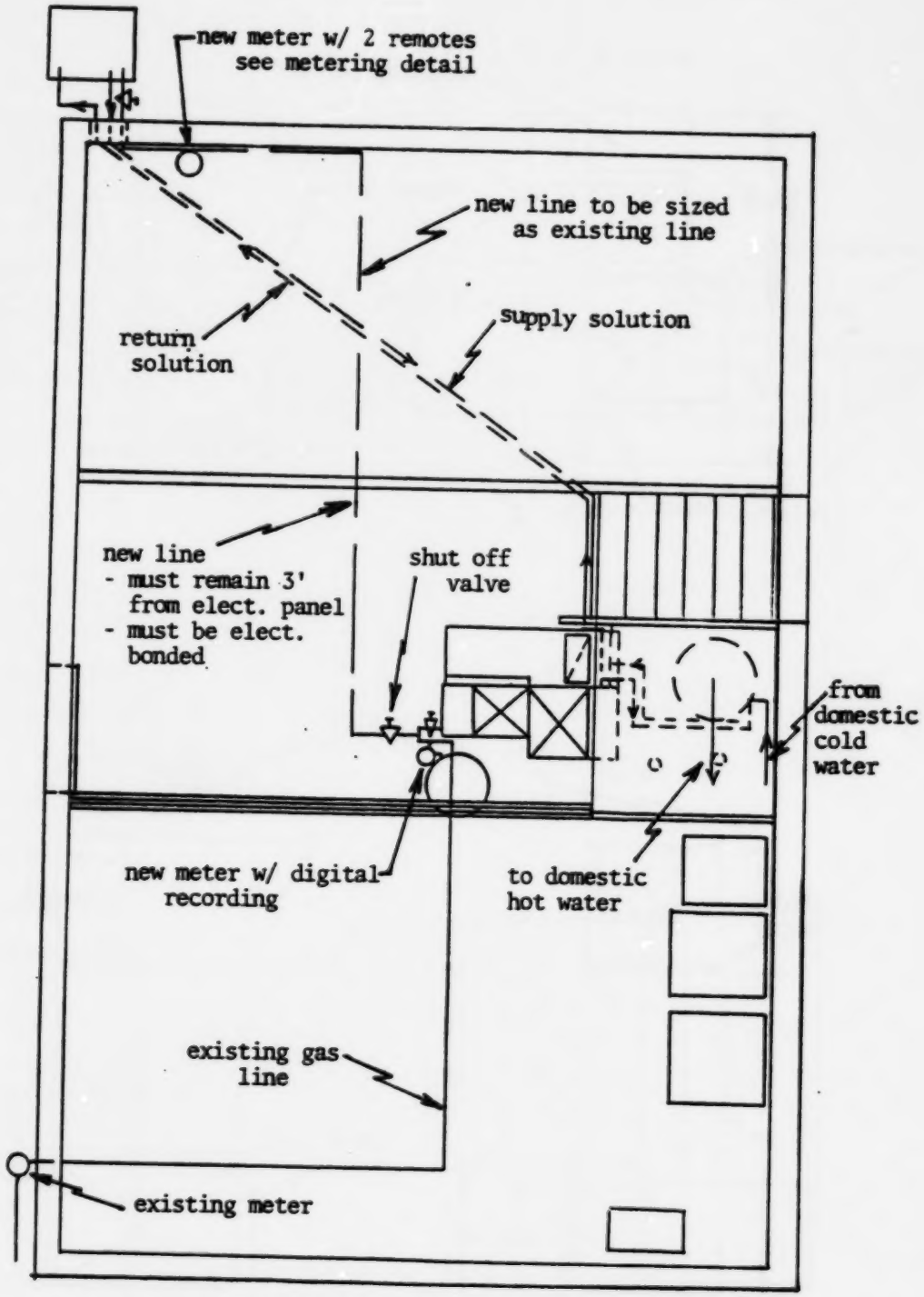


Note -some detail omitted for clarity
-do not scale drwg.

Scale: ¼"=1'
Drawn By: R.B.
Sept. 29 /82

fig. 5

GAS PIPING AND SOLUTION SYSTEM



Note - some detail omitted for clarity

Not to scale
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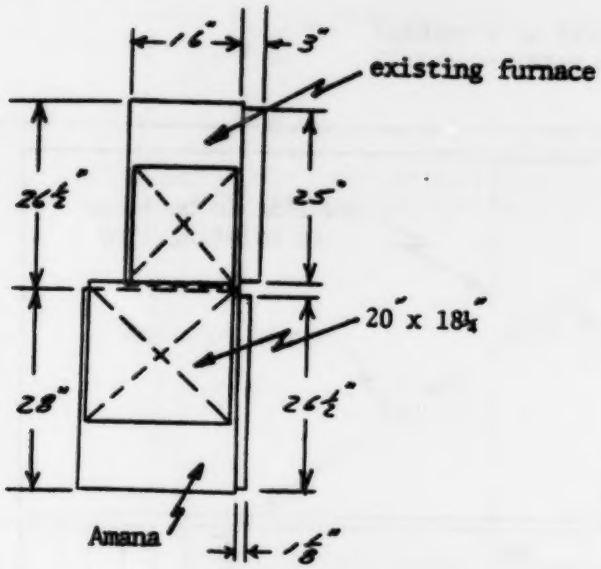
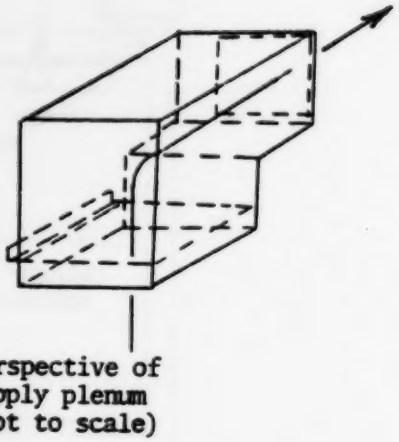
Sept. 30 /82

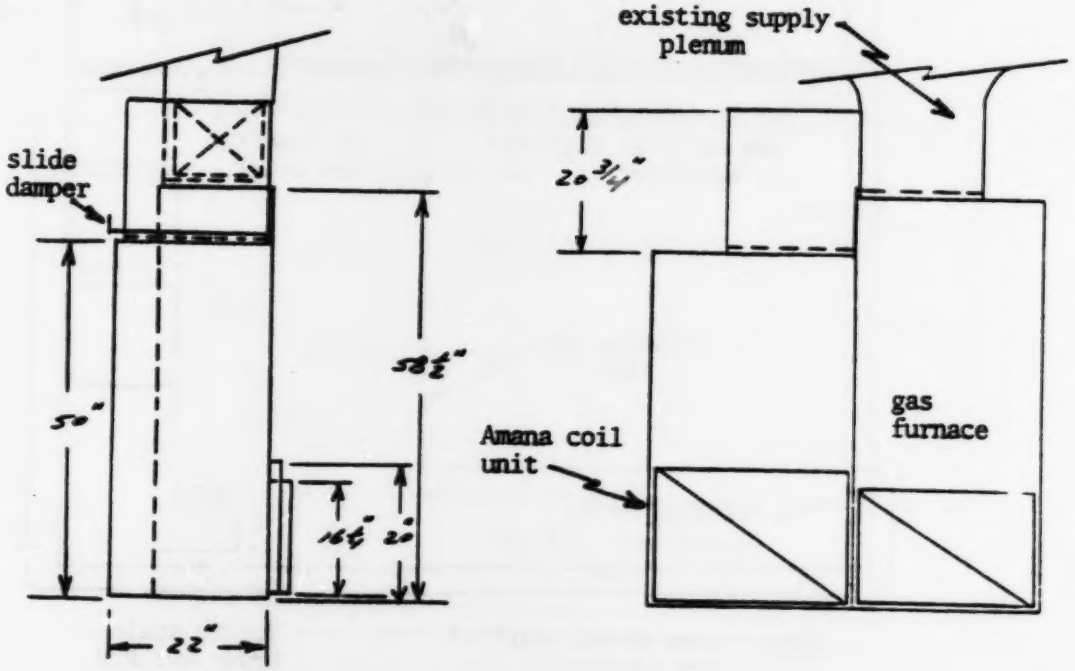
fig. 6

SUPPLY DUCTING





perspective of
supply plenum
(not to scale)



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for clarity
- do not scale drwg.

Scale: ½"=1'
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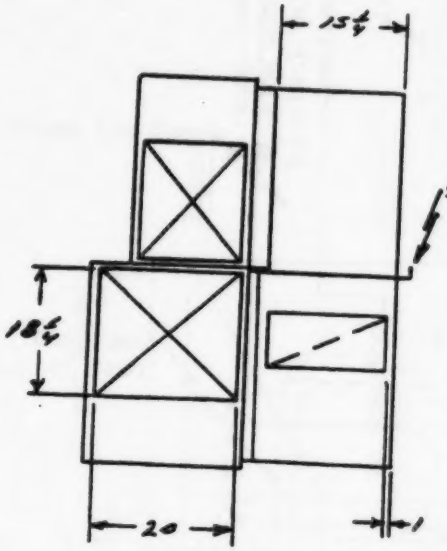
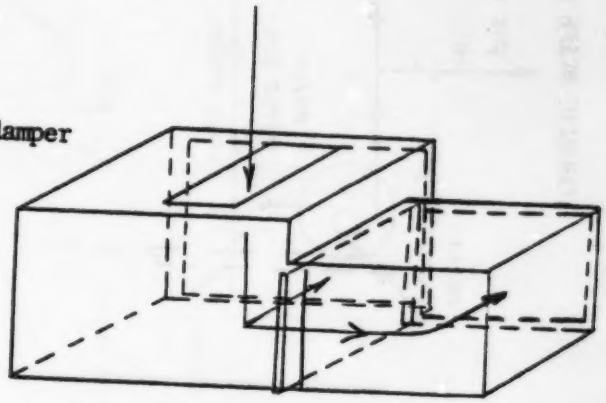
Sept. 29 /82

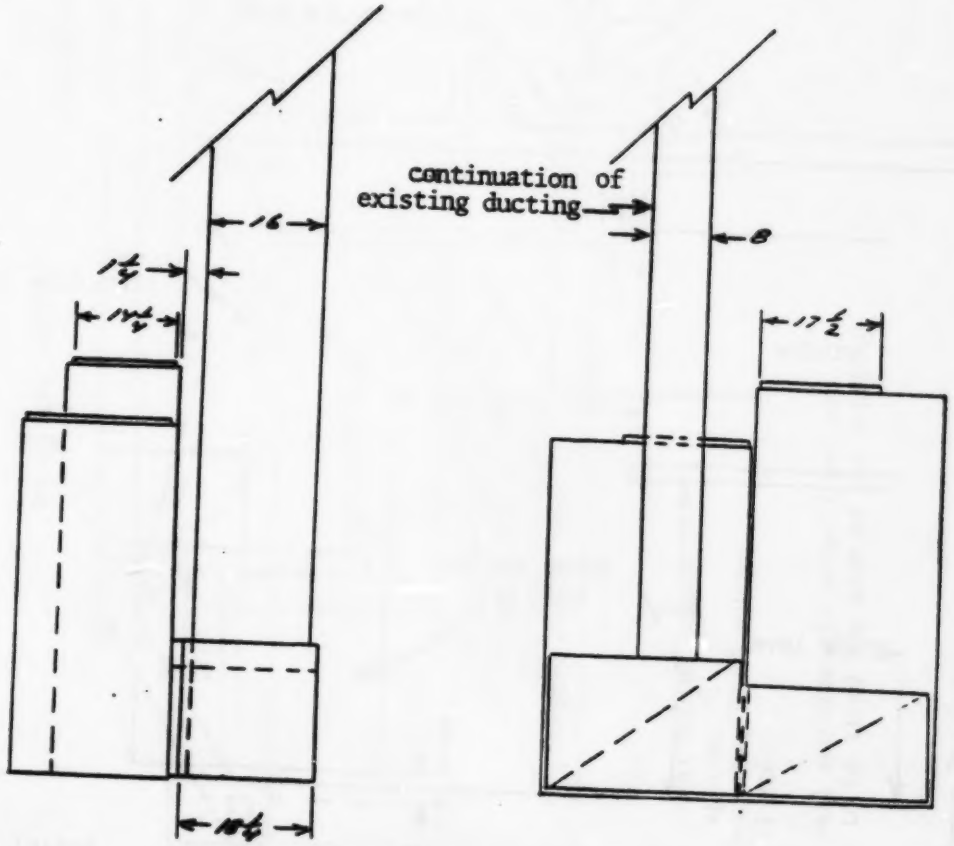
fig. 7

RETURN DUCTING





perspective of return plenum (not to scale)



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- do not scale drwg. (in inches)

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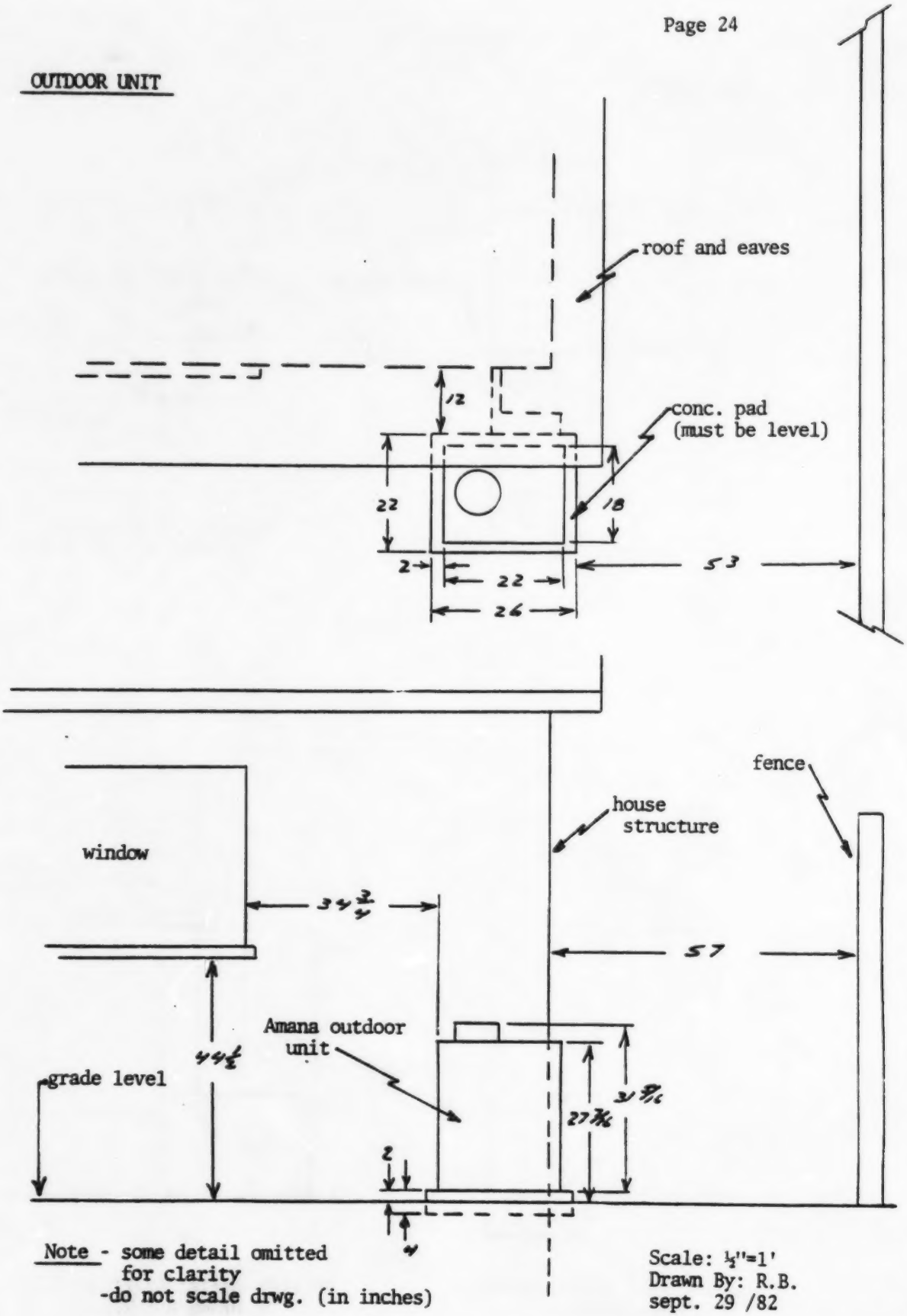
Sept. 29 /82

fig. 8

OUTDOOR UNIT

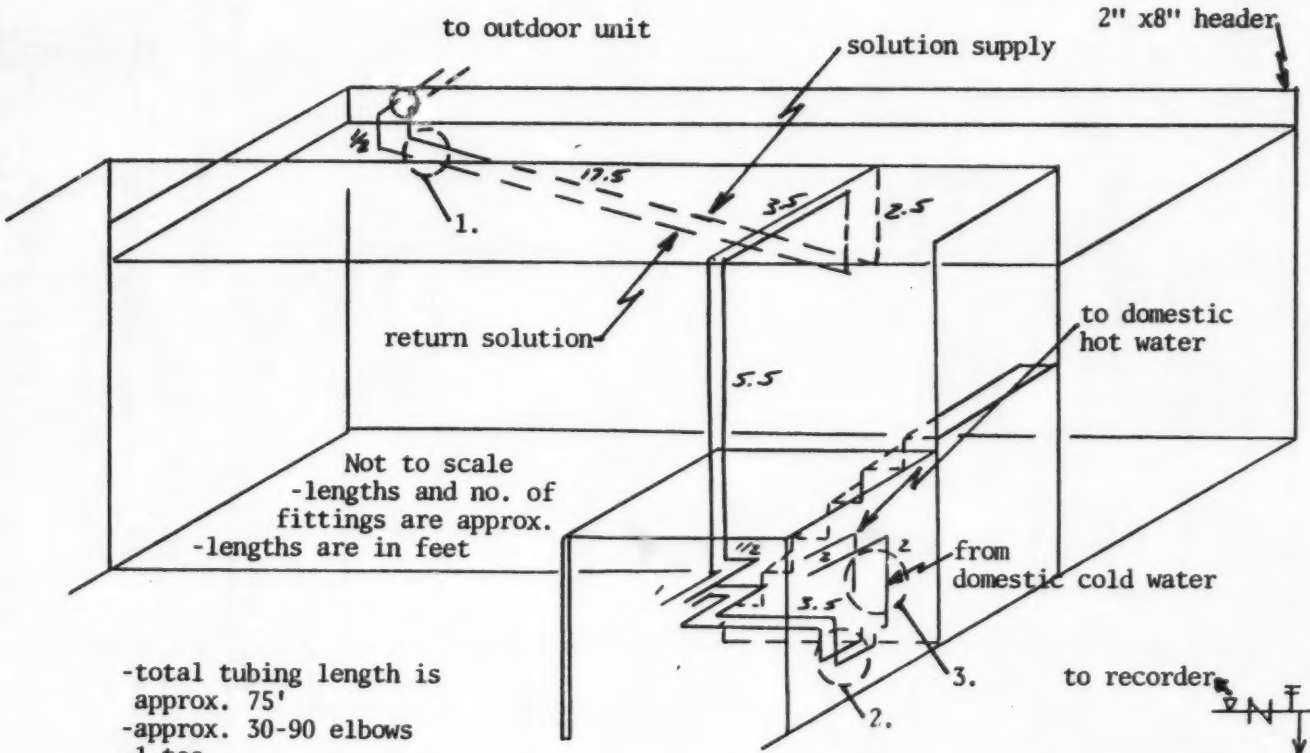


Note - some detail omitted
for clarity
-do not scale drwg. (in inches)

Scale: ½"=1'
Drawn By: R.B.
sept. 29 /82

fig. 9

PERSPECTIVE OF SOLUTION PIPING



-total tubing length is approx. 75'
-approx. 30-90 elbows
-1 tee

-all new domestic water lines are to be sized the same as the existing

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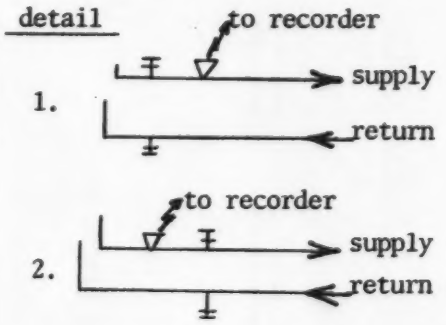
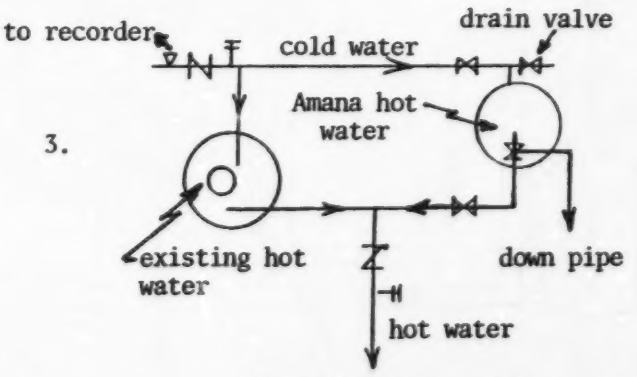
Sept. 30 /82

legend

-temp. sensor
-flow meter
-check valve (positon vertically)

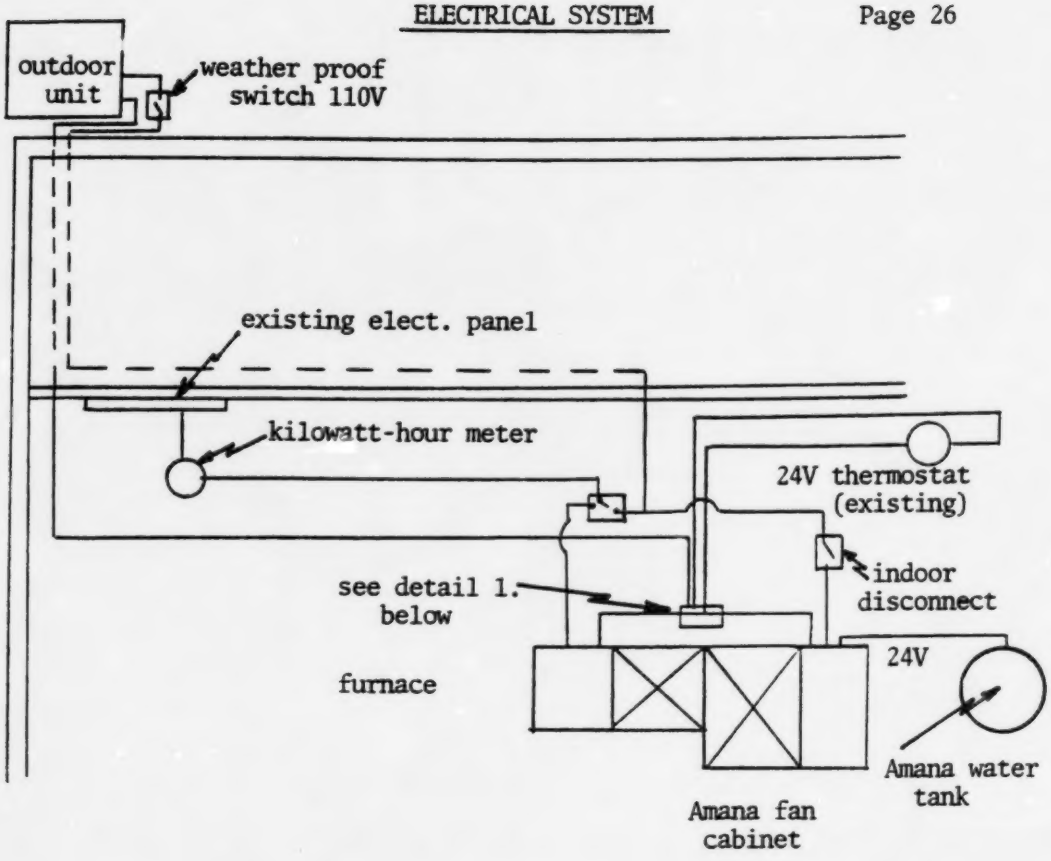
detail



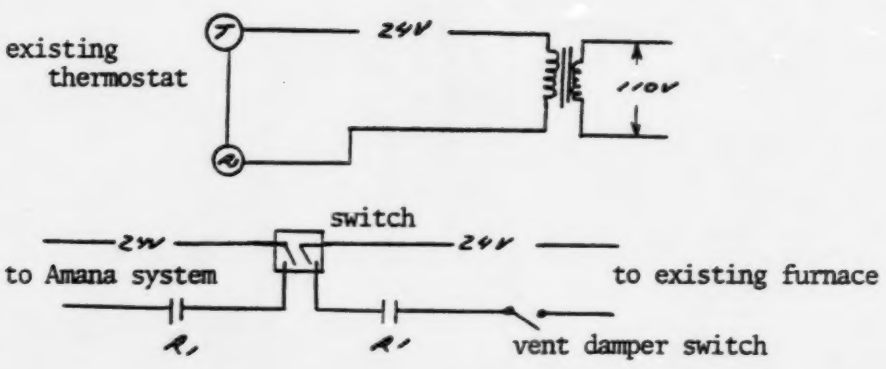


DOMESTIC WATER SUPPLY

fig. 10



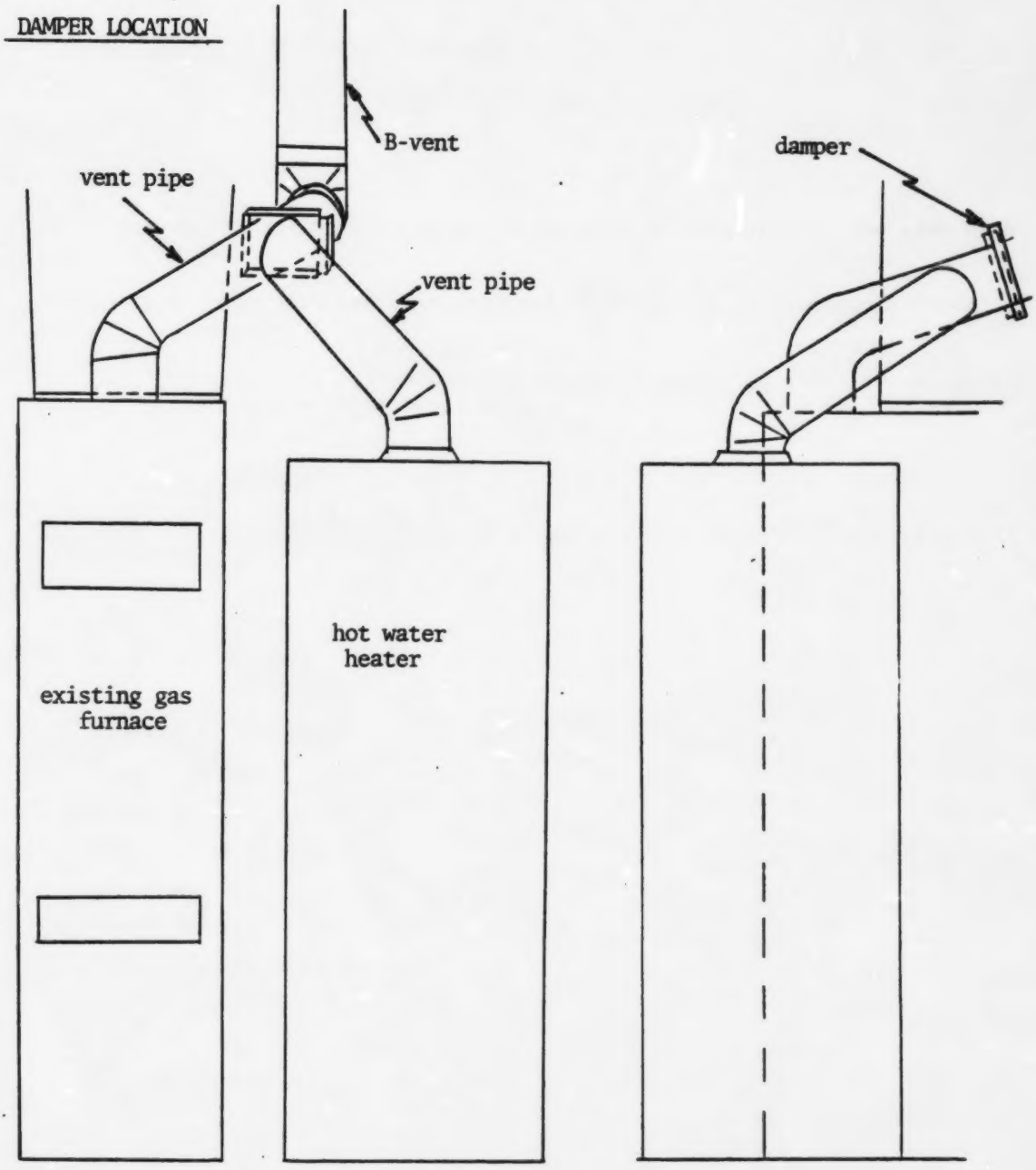
THERMOSTAT DETAIL- 1.



Not to scale
Drawn By: R.B.
Sept. 30 /82

fig. 11

DAMPER LOCATION



Note - some detail omitted for clarity
- not to scale

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Sept. 30 /82

-the selected design must be approved by this department

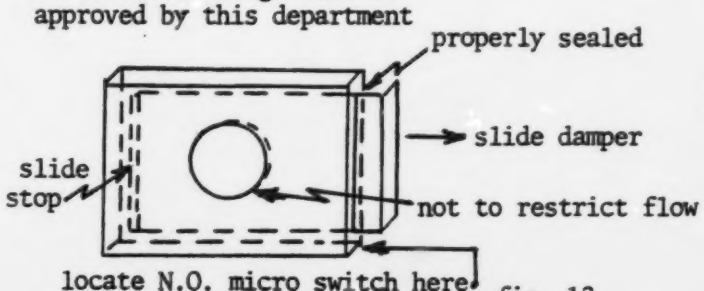


fig. 12

APPENDIX D - HOMEOWNER'S PACKAGE

OPERATION OF TEST /GAS SYSTEM

GENERAL INSTRUCTIONS

i) The flip/flop changes are to be made at or near the same time each week.

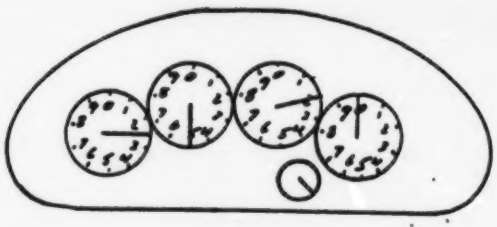
ii) A check list has been enclosed to assist in alternating between systems.

iii) In recording kilowatt hours (KWH), care must be taken in correctly reading the meters (see attachment).

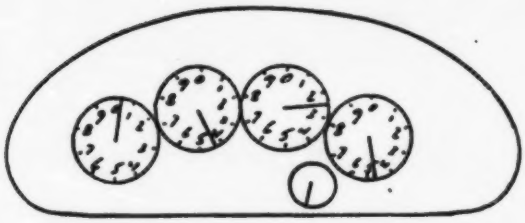
DATA REQUIREMENTS

Upon switching furnace operation, the following data should be recorded:

DATA	COLUMN
Date (day/month)	1
Time	2
Electrical Consumption	5
Operation (✓)	6
Conv. DHW Gas Consumption	7
Gas Furnace Consumption	8
Amana Gas Consumption	9
Number of DHW Cycles	10
Total Elapsed Time for DHW	10
Energy	12

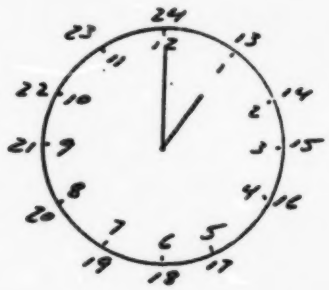


Record as 2520 kwh



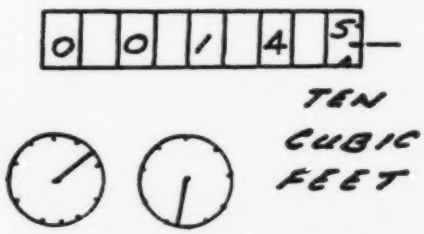
Record as 424 kwh

In recording time, the hundred hour clock should be used:



Record 1 PM as 1300 hrs.

In recording gas, record to the nearest half.



Record as
144.5

CHECK LIST

AMANA SYSTEM OPERATION

DATES:

1. Shut off gas to conventional furnace.
2. Cut main (115V) power to furnance.
3. Shut off gas to conventional domestic hot water.
4. Close off flue with damper, securing it with pin.
5. Close off hot water supply from conventional DHW.
6. Record BTU readings: (12)
   - A) Outdoor unit
   - B) Amana DHW glycol supply
   - C) Domestic water
   - D) Space heating
7. Record gas consumption:
   - i) Furnace operation (8)
   - ii) Conventional hot water (7)
   - iii) Amana outdoor unit (9)
8. Record operating cycles and elapsed time. (10)
9. Remove blade damper from supply, and cap.
10. Remove cap and insert return air damper blade.
11. Record electrical consumption. (5)
12. Open hot water supply from Amana tank.
13. Switch on main (115V) power to Amana fan unit.
14. Turn on gas to outdoor unit.
15. Switch thermostat control to Amana system. (6)

CHECK LIST

CONVENTIONAL SYSTEM OPERATION

DATES:

1. Switch thermostat to furnace operation. (6)
2. Shut off gas to outdoor unit.
3. Cut main power (115V) to Amana indoor fan cabinet.
4. Open flue damper, assuring that blade is not obstructing flue.
5. Close hot water valve from Amana tank.
6. Record BTU readings: (12)
   - A) Outdoor unit
   - B) Amana DHW glycol supply
   - C) Domestic water
   - D) Space heating
7. Record gas consumption:
   - i) Furnace operation (8)
   - ii) Conventional hot water (7)
   - iii) Amana outdoor unit (9)
8. Record operating cycles and elapsed time. (10)
9. Record electric consumption. (5)
10. Remove return air damper blade and cap.
11. Remove cap and insert blade damper in supply section.
12. Open hot water supply from conventional DHW.
13. Turn on gas to conventional DHW Tank, and light pilot.
14. Turn gas on to furnace, and light pilot.
15. Switch on main power (115V) to furnace.

TITLE: HIGH EFFICIENCY HEATING STUDY

LOCATION: CHATHAM

PERIOD: _____

INDOOR TEMP. SETTING: _____

1	2	3	4	5 Elec. Cons. (KWH)		6 Operation		FUEL CONSUMPTION - I 7 Conv. DHW (cu. ft.)		8 Conv. Furn. (cu. Ft.)		FUEL CONSUMPTION - II 9 Amana (cu. ft.)		10 Dom. H.W.			11 Totals (cu.ft.)		12 Energy (BTU's)	
Date	Time	Total Hrs.	Δ Hrs.	Rdg. A	Diff. B	Conv.	Amana	Rdg. C	Diff. D	Rdg. E	Diff. F	Rdg. G	Diff. H	# of Cycles	Time (hrs.) I	Diff. (hrs.) J	DHW K	Air L	Rdgs. M	Diff. N
																			A	
																			B	
																			C	
																			D	
																			A	
																			B	
																			C	
																			D	
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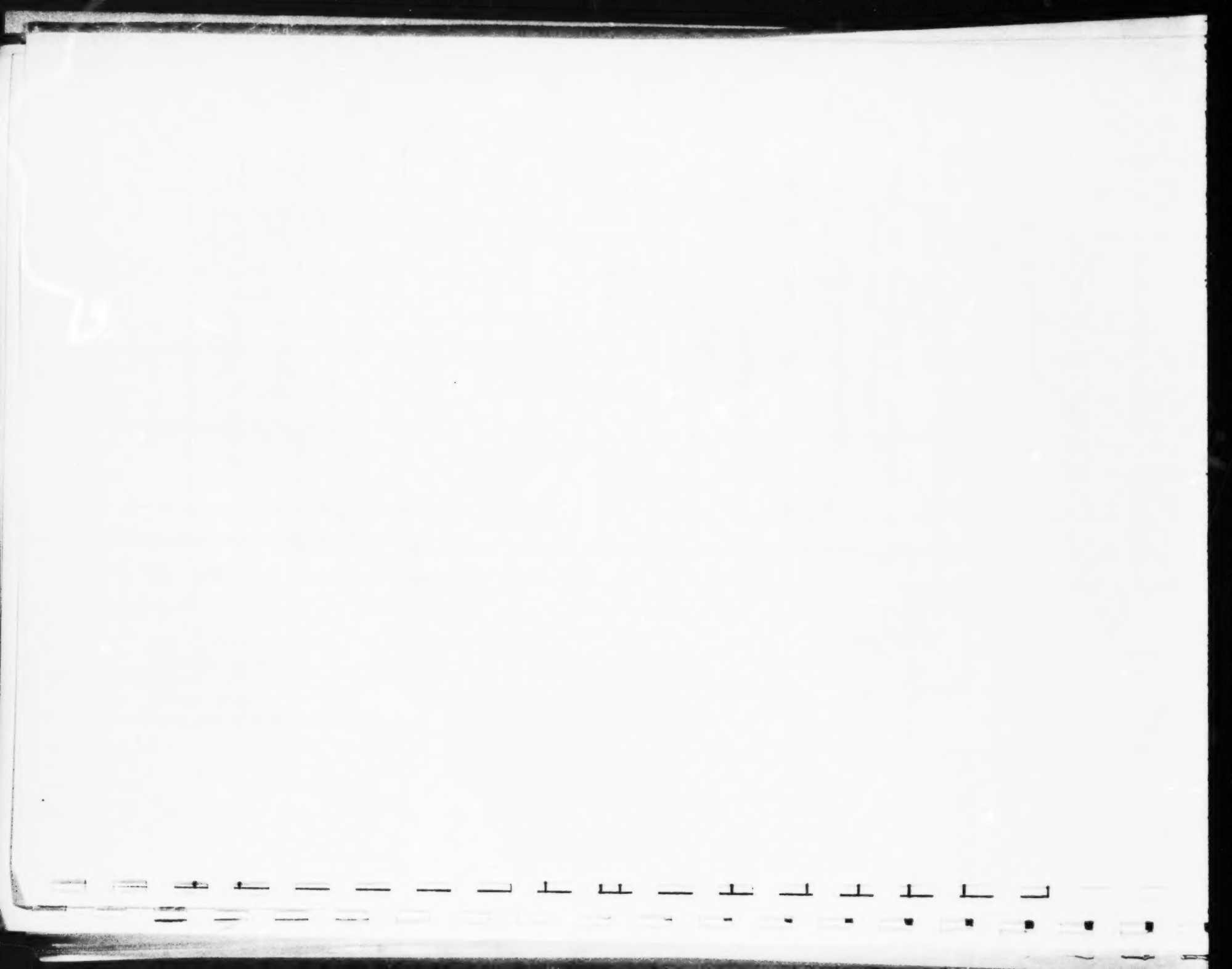

INSTALLATION COSTS[1]

Installation of DHW/Space Heating System

Materials	$494.00
Labour	704.00
Tax	32.55
Purchase of unit[2]	3,334.93
TOTAL[3]	$4,565.48

NOTES:

1 Costs as quoted by the contractor

2 The purchase price of the furnace is approximate in that it represents a typical retail price; actual prices may vary. These prices do however include freight and taxes.

3 This total is representative of an actual installation study related costs are summarized in Appendix F.

MONITORING COSTS

Installation of study materials	$642.94
Additional metering	3,331.83
Local delivery	15.00
Gas indexes	30.00
Miscellaneous (glycol, wiring, water)	47.62
TOTAL[1]	$4,067.39

NOTE:

1 Costs are as of this writing and subject to change upon receipt of all invoices.

POOR

QUALITY

ORIGINAL